CONODONT BIOSTRATIGRAPHY OF THE LEXINGTON LIMESTONE AND TYRONE LIMESTONE IN INDIANA GEOLOGICAL SURVEY DRILL CORE # 133

Senior thesis presented in partial fulfillment
of the requirements for the Bachelor of Science
Degree at The Ohio State University

By James E. Geitgey

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Approved by ______________

Advisor

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INTRODUCTION

The Middle and Upper Ordovician strata of the Cincinnati Region have been the subject of intensive study for quite some time. One particular area of study, for approximately the past 25 years, has been the use of conodonts for biostratigraphic correlations of sections within the region. Dr. Walter C. Sweet of The Ohio State University has correlated numerous sections from this area into a master log. The basis for these correlations has been the use of relative-abundance logs of certain conodont species.

Drill core #133, 500 feet in length, was obtained by the Indiana Geological Survey near the town of Patriot, Switzerland County, Indiana (figs. 1&2). The core was sampled at five-foot intervals. These samples were then sent to The Ohio State University in August of 1965, where they were given the designation 65GZ and processed in the acid lab to obtain conodont-bearing residues. During 1966 and 1967 some of the samples were tabulated by Dr. Sweet; however, analysis and tabulation were not completed at that time.

In the Cincinnati Region, sections extending below the base of the Lexington Limestone are few, and it was hoped that data obtained from 65GZ would contribute to our knowledge of this interval of the stratigraphic record. The writer was also desirous to develop a clearer understanding of the nature of the Lexington Limestone-Tyrone Limestone boundary in this area.

A third objective of this project was to attempt to judge the effect of a different sampling method than that typically used by workers at The Ohio State University. This technique is more fully described in the Methods section of this paper.

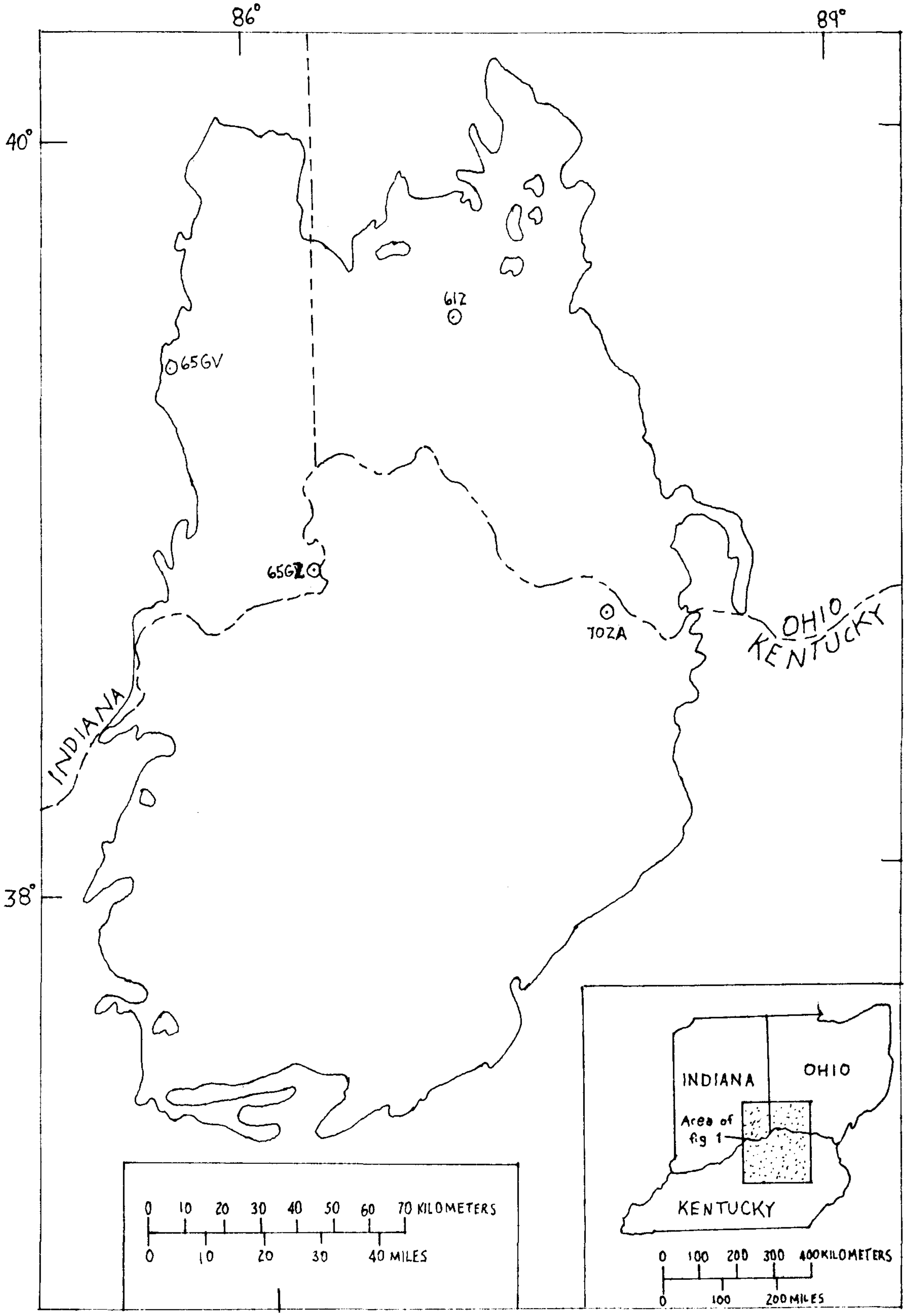

Figure 1: Geographic locations of sections referred to in this paper. Irregular outline indicates Ordovician outcrop in the Cincinnati Region. (Modified from Sweet, 1979)

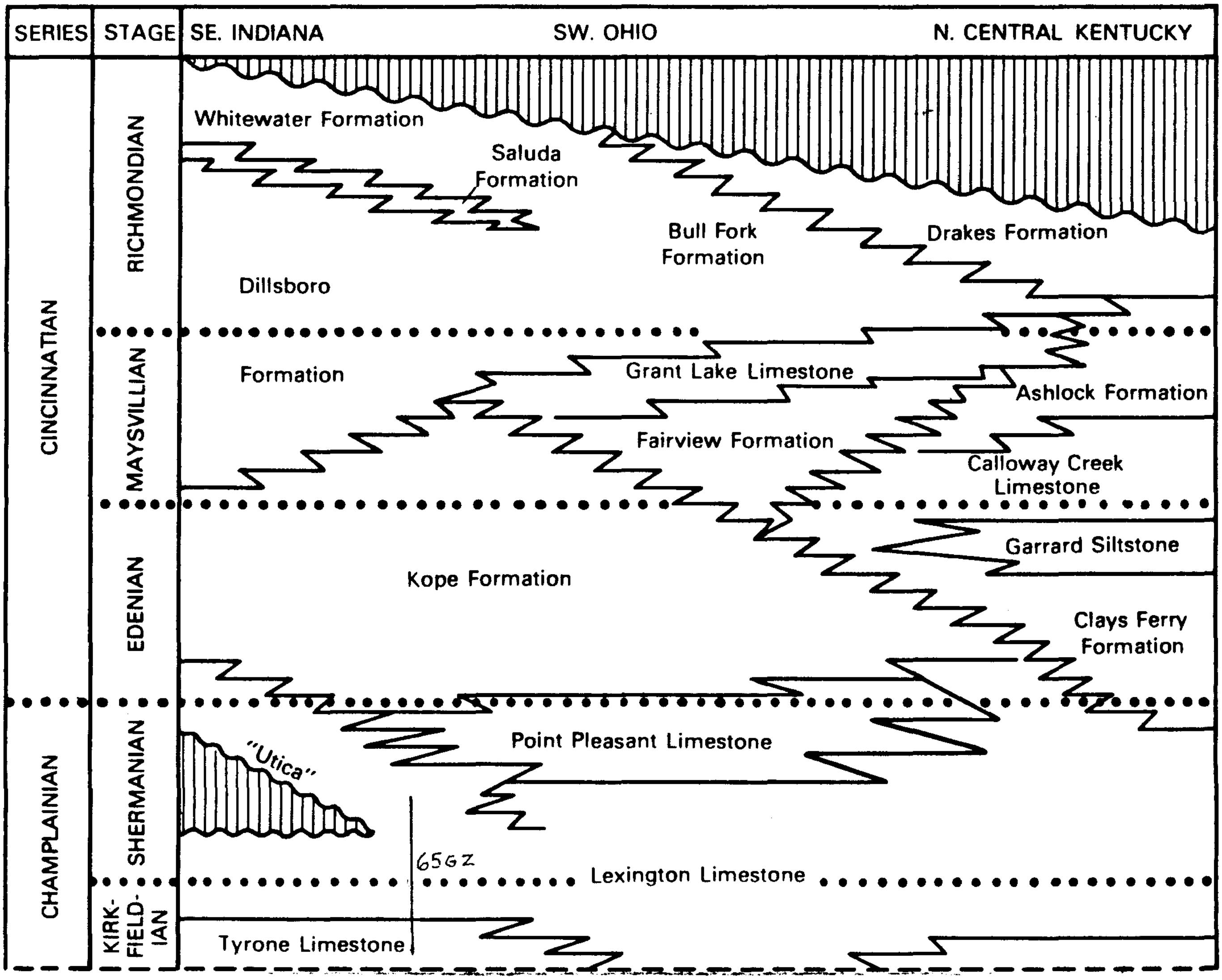

Figure 2: Stratigraphic relationships of Middle and Upper Ordovician rocks in the Cincinnati Region. Vertical bar indicates the approximate stratigraphic location of 65GZ. (Modified from Sweet, 1979)

ACKNOWLEDGMENTS

The author wishes to thank Dr. Walter C. Sweet of The Ohio State University, Department of Geology, for his suggestion of this project. Appreciation is also expressed for his guidance during its completion.

METHODS

Samples from drill core #133 were taken every five feet; however, considering the large number of conodonts present in many samples, and the time constraints involved, the writer picked conodonts from residues spaced every ten feet apart. Due to the previous work of Dr. Sweet, there were some intervals of the core in which samples were obtained every five feet.

Analysis of the samples was done by picking specimens from a ruled tray and depositing them on micropaleontological slides. Specimens were sorted into form-species and then grouped into appropriate multi-element species. All specimens present in the first two samples were picked. This procedure proved very tedious because more than 1,000 specimens were picked from each of the first two samples. It was at this point that discussion with Dr. Sweet brought up the possibility of picking conodonts from only a portion of the residues, for relative abundances were all that was needed. It had been the experience of Dr. Sweet, that in determining the statistical accuracy of collections of conodonts, those samples containing fewer than approximately 100 specimens or more than 250 specimens were the least reliable. It was then decided that the remaining samples would be split into halves, thirds, etc. and these portions would be picked so as to obtain approximately 200 specimens. It should be noted that an effort to be completely random in the fractioning of the residues was made, and that the first approximately 200 specimens encountered were collected. The majority of specimens recovered from most samples represent two species, Phragmodus undatus and Plectodina tenuis, and it can be assumed that their relative abundances were not greatly influenced by failure to pick samples entirely clean. However, more doubt can be expressed as to the effect this sampling method had on the many other species that were less abundantly represented. It is realized that definitive proof of the accuracy of this partial sampling technique can be obtained only by going back and completely picking all the samples and comparing the results. It is submitted, however, that the relative-abundance log obtained for 65GZ in this report (fig. 3) appears to match the master log (fig. 4) reasonably well, so no reason to doubt the accuracy of this log is readily apparent.

RELATIVE-ABUNDANCE LOG CONSTRUCTION

The methodology and reasoning used in constructing relative-abundance logs for conodont faunas in the Cincinnati Region have been discussed in previous papers (Bergström and Sweet,1966; Sweet, 1979). However, a short synopsis of facts pertinent to the construction made in this paper is given.

Briefly, the studies of various workers (Sweet and others, 1959; Pulse and Sweet,1960; Sweet and Schönlaub,1975; Bergström and Sweet,1966; Kohut and Sweet,1968; Seddon and Sweet,1971; Sweet,1979) have determined that conodont faunas of the Cincinnati

Region contain components from a "North Atlantic Province" and a "North American Midcontinent Province." Each of these provinces is represented by a particular conodont assemblage. The North American Midcontinent Province has been further divided into "exterior" and "interior" subprovinces. Study of the conodonts collected from the Cincinnati Region has revealed that the majority of the elements are representative of the exterior subprovince of the North American Midcontinent Province (Sweet, 1979). This assemblage is dominated by the genera Phragmodus and Plectodina. It was also recognized that in the Cincinnati Region the exterior subprovince is further separable into northern and southern elements (Kohut and Sweet,1968). It was proposed that the northern element, characterized by Phragmodus undatus and Plectodina, was representative of waters over deeper depositional sites, with Phragmodus undatus the deeper-, and Plectodina the shallower-water representatives. The southern element, characterized by Aphelognathus, Oulodus, and "fibrous conodonts," appears to be indicative of shallower depositional areas. This relationship of assemblages to depth was based on lithological evidence.

Due to the fact that most of the species present in the Middle and Upper Ordovician rocks of the Cincinnati Region are long ranging, and thus of little use stratigraphically within this interval, it was suggested in 1965 by Sweet, Bergström, and Rust that relative-abundance logs of the more characteristic and abundantly represented species could be used for purposes of biostratigraphic correlation. It was proposed that by plotting the fluctuations between deeper-water species of genera such as Phragmodus and Plectodina and shallower-water species of genera such as Oulodus, *Aphelognathus*, *Rhipidognathus*, and fibrous conodonts, one could develop a log that could be correlated with others in the region. These correlations assume that fluctuations of water depth were basin wide.

With these points in mind, the writer constructed a relative-abundance log for samples from 65GZ (fig.3).

INTERPRETATIONS AND CORRELATIONS

From inspection of the relative-abundance log, the history of water-depth fluctuation in the basin at this time can be surmised. As is seen, representatives of the southern element, indicative of very shallow water, dominate throughout most of the Tyrone Limestone. There do occur several deeper-water pulses, as indicated by the presence of *Plectodina*, but no species of *Phragmodus* are present. Moving across what is proposed as the boundary between the Tyrone and Lexington Limestones, an increase in water depth is indicated by the appearance and domination of *Phragmodus undatus*. This represents encroachment of the northern element over the southern. During deposition of the Lexington Limestone, there are several regressive pulses, as indicated by brief appearances of representatives of the southern element.

Figure 4 shows how 65GZ has been correlated with three other sections taken from the master log. The geographic locations for all sections are shown in figure 1. It should be noted that the relative positions of sections 65GV, 61Z, and 70ZA were established in the master log by graphic correlation. Section 65GZ is the only one that has been "fitted in" in figure 4. The three sections shown in figure 4 are the most compatible of those in the master log with 65GZ.

Data for post-Tyrone strata are fairly well represented; however, very few data are available for older strata. Correlation of 65GZ was made by attempting to align as many of the fluctuation "peaks" as possible between the sections. This is shown in figure 4 by the dashed horizontal lines. 65GZ appears to correlate best with 70ZA, a long core drilled near Minerva, Kentucky (Sweet, Harper, and Zlatkin, 1974). The resolution of 65GZ does not appear to be as detailed as that of the other cores, however, this is probably attributable, at least in part, to the 10-foot interval used in much of the sampling. Another point to bear in mind is that the process of tracing and xeroxing the sections has probably distorted them somewhat. Nonetheless, it seems that enough systematic fluctuation is present to make a reasonable correlation.

It is immediately apparent upon examining figure 4 that the Lexington and Tyrone Limestones have been separated for correlation. This represents a hiatus amounting to the equivalent of 50 feet of strata, and is roughly equivalent to the one present in 70ZA. Determination of the amount of gap represented in 65GZ was based on correlation of the two lower sections. This correlation represents the best possible "fit." While the correlation of the Lexington section appears reasonably accurate, the Tyrone correlation must be viewed with more suspicion. For one thing, the number of specimens present in samples from the Tyrone in 65GZ was typically very low (Table 1). This tends to exaggerate fluctuations. Secondly, much of the section was represented by samples that were barren of conodonts, and thus provide no data. It should be noted that due to the sparse nature of the samples from the Tyrone, all were picked clean.

In addition to the correlation of the Tyrone section of 65GZ with that of 70ZA to indicate an unconformity, there are other points to consider. One is the drastic change in water depth across the boundary in 65GZ. Moving from the base of the Tyrone section upward, conodonts of a shallow-water nature dominate, as indicated by the prevalence of fibrous conodonts. At the base of the Lexington, there is seen to be a rapid increase in water depth in the basin, as indicated by the appearance and increase in abundance of Phragmodus undatus. Thus, the Lexington section can be characterized as representative of the deeper-water northern element. The Tyrone section, on the other hand, is indicative of the shallow-water southern element. A second point to note is the change in the nature of the faunal assemblage across the boundary. In examining this change, it must be noted that at least some of the faunal turnover is due to the changing nature of the water depth. However, it is impossible to say at this time that all appearances or disappearances of species across this boundary were the result of fluctuations in water depth. From examination of figure 3 and table 1, it is apparent that Plectodina aculelata occurs only in the Tyrone, up to a level 330 feet below the top of the core, or 15 feet below the proposed Lexington-Tyrone boundary. In the Lexington, the first appearances of Amorphognathus sp., Bryantodina abrupta, B. staufferi, Icriodella superba, Plectodina tenuis, Pseudo-belodina sp., and Rhodesognathus elegans all occur at to within 15 feet of the boundary. Thus, of the 14 species represented in section 65GZ, only four cross the Lexington-Tyrone boundary.

In view of the aforementioned facts, it would appear reasonable to regard the contact between the Lexington and Tyrone Limestones in drill core #133 as unconformable, a view that is held for the contact in general (Bergström and Sweet, 1966). However, due to the previously discussed problems, it is more difficult to quantify the amount of missing strata. A more definitive answer to this question should manifest itself as more and more data are collected for this area.

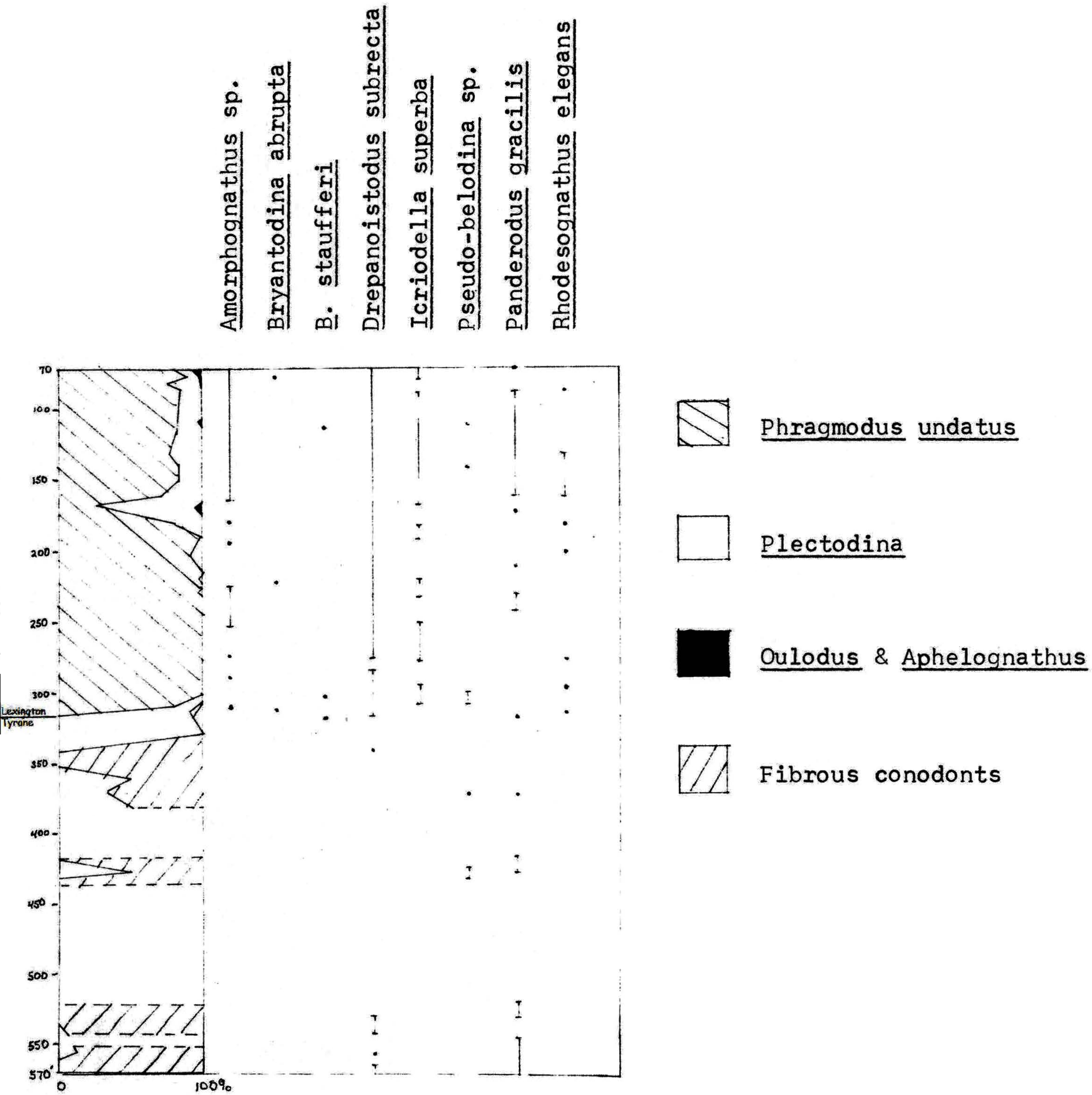

Figure 3: Relative-abundance log and stratigraphic ranges of species within 65GZ.

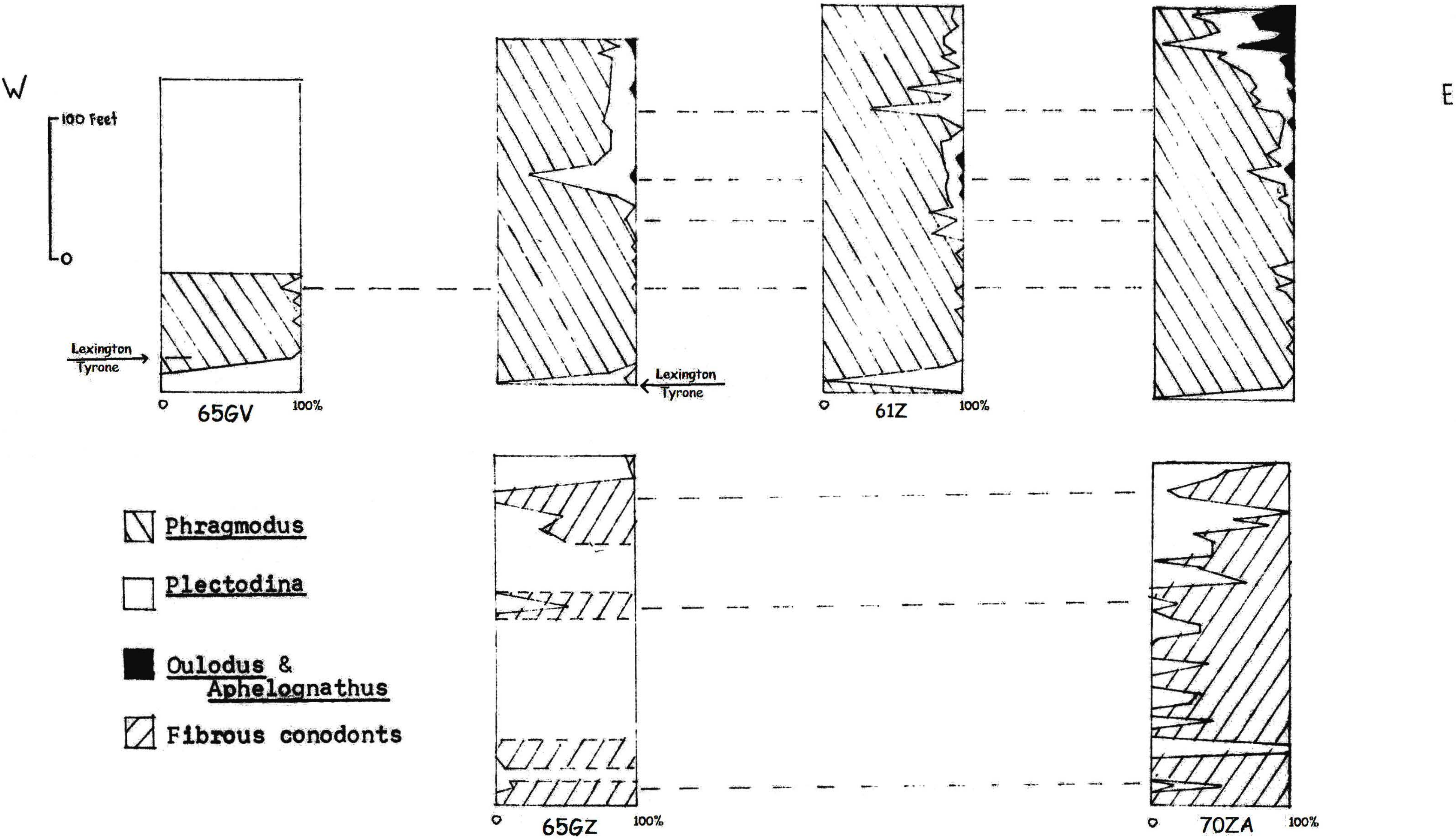

Figure 4: Correlation of 65GZ with 65GV, 61Z, & 70ZA, based on relative-abundance logs.

Table 1: Tabulation of conodont species in 65GZ.

Sample Number	Phragmodus undatus	Plectodina	Oulodus, Aphelognathus, Fibrous conodonts
70	31	6	3
75	1885	195	11
80	130	37	1
85	495	83	-
110	446	79	5
120	530	115	-
130	993	248	-
140	61	12	-
150	150	30	-
160	75	29	-
165	16	51	-
170	31	41	-
180	57	5	-
190	64	-	-
200	48	3	-
210	43	1	-
220	93	1	-
230	101	1	-
240	149	-	-
250	125	1	-
255	138	-	-
260	120	-	-
270	22	-	-
275	58	-	-
280	4	-	-
285	10	-	-
290	7	-	-
295	19	-	-
300	142	-	-
310	284	52	16
315	7	60	6
330	-	3	-
340	-	-	8
350	-	-	1
360	-	1	1
370	-	1	2
380	-	1	1
400	-	3	1
415	-	-	5
425	-	1	1
430	-	-	2
435	-	-	4
455	-	-	1
520	-	-	3
530	-	-	1
540	-	1	22
545	-	-	-
550	-	1	9
555	-	1	8
560	-	-	1
565	-	-	6
570	-	-	4

Total: 7,639

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